

# Exhibit AA

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## Excess Deaths From COVID-19 and Other Causes in the US, March 1, 2020, to January 2, 2021

A study analyzing US mortality in March-July 2020 reported a 20% increase in excess deaths, only partly explained by COVID-19. Surges in excess deaths varied in timing and duration across states and were accompanied by increased mortality from non-COVID-19 causes.<sup>1</sup> This study updates the analysis for the remainder of 2020.

**Methods |** The [Supplement](#) details the methods. A Poisson regression model used mortality data from 2014-2019 to predict US expected deaths in 2020. Observed deaths in weeks ending March 1, 2020, through January 2, 2021, were taken from provisional, unweighted death counts for the District of Columbia and 49 states, excluding North Carolina for insufficient data. Data sources included the National Center for Health Statistics<sup>2-4</sup> and US Census Bureau.<sup>5</sup> Data for 8 geographic regions were grouped into distinctive surge patterns. COVID-19 deaths included all deaths for which COVID-19 was cited as an underlying or contributing cause.

Temporal changes in mortality rates from non-COVID-19 causes (eg, Alzheimer disease/dementia, heart disease, diabetes, and 9 other grouped causes; see [Supplement](#)) were examined. Data included all deaths in which non-COVID-19 conditions were listed as the underlying cause of death (potentially including deaths for which COVID-19 was a contributing cause). The Joinpoint regression program version 4.8.0.1 (Statistical Research and Applications Branch, National Cancer Institute) was used to specify the weeks (joinpoints) when slopes changed (measured by the annual percentage change [APC]) and their statistical significance (2-sided test,  $\alpha = .05$  threshold).

**Results |** Between March 1, 2020, and January 2, 2021, the US experienced 2 801 439 deaths, 22.9% more than expected, representing 522 368 excess deaths ([Table](#)). The excess death rate was higher among non-Hispanic Black (208.4 deaths per 100 000) than non-Hispanic White or Hispanic populations (157.0 and 139.8 deaths per 100 000, respectively); these groups accounted for 16.9%, 61.1%, and 16.7% of excess deaths, respectively. The US experienced 4 surge patterns: in New England and the Northeast, excess deaths surged in the spring; in the Southeast and Southwest, in the summer and early winter; in the Plains, Rocky Mountains, and far West,



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Table. Excess Deaths, March 1, 2020, to January 2, 2021, US and Selected States and Regions

Jurisdiction	Expected deaths (95% CI) <sup>a</sup>	Observed deaths (ratio of observed to expected)	Excess deaths, No. (95% CI)	Excess deaths/ 100 000 <sup>b</sup>	COVID-19 deaths <sup>c</sup>	Excess deaths attributed to COVID-19, % <sup>c</sup>
US <sup>d</sup>	2 279 071 (2 278 117 to 2 280 026)	2 801 439 (1.23)	522 368 (521 413 to 523 322)	164.4	378 039	72.4
Alabama	43 621 (43 495 to 43 747)	54 361 (1.25)	10 740 (10 614 to 10 866)	219.0	6767	63.0
Alaska	3740 (3719 to 3761)	4205 (1.12)	465 (444 to 486)	63.6	167	35.9
Arizona	50 305 (50 166 to 50 443)	66 378 (1.32)	16 073 (15 935 to 16 212)	220.8	9523	59.2
Arkansas	26 652 (26 561 to 26 742)	32 300 (1.21)	5648 (5558 to 5739)	187.2	4077	72.2
California	223 220 (222 892 to 223 548)	273 584 (1.23)	50 364 (50 036 to 50 692)	127.5	34 350	68.2
Colorado	33 680 (33 573 to 33 787)	40 636 (1.21)	6956 (6849 to 7063)	120.8	5123	73.6
Connecticut	25 837 (25 749 to 25 925)	32 379 (1.25)	6542 (6454 to 6630)	183.5	6222	95.1
Delaware	7618 (7582 to 7654)	9278 (1.22)	1660 (1624 to 1696)	170.5	914	55.0
District of Columbia	5104 (5078 to 5130)	6370 (1.25)	1266 (1240 to 1292)	179.4	927	73.2
Florida	175 117 (174 826 to 175 409)	206 940 (1.18)	31 823 (31 531 to 32 114)	148.2	22 013	69.2
Georgia	71 514 (71 341 to 71 687)	88 079 (1.23)	16 565 (16 392 to 16 738)	156.0	10 449	63.1
Hawaii	9735 (9692 to 9778)	10 012 (1.03)	277 (234 to 320)	19.6	281	101.4
Idaho	11 721 (11 671 to 11 771)	14 117 (1.20)	2396 (2346 to 2446)	134.1	1506	62.9
Illinois	88 632 (88 436 to 88 829)	110 524 (1.25)	21 892 (21 695 to 22 088)	172.8	16 843	76.9
Indiana	55 892 (55 743 to 56 040)	66 603 (1.19)	10 711 (10 563 to 10 860)	159.1	9602	89.6
Iowa	25 336 (25 249 to 25 424)	30 368 (1.20)	5032 (4944 to 5119)	159.5	4814	95.7
Kansas	22 059 (21 980 to 22 138)	26 506 (1.20)	4447 (4368 to 4526)	152.6	3527	79.3
Kentucky	40 166 (40 046 to 40 286)	47 241 (1.18)	7075 (6955 to 7195)	158.4	4651	65.7
Louisiana	38 475 (38 358 to 38 591)	48 468 (1.26)	9993 (9877 to 10 110)	215.0	7068	70.7
Maine	12 415 (12 363 to 12 468)	13 086 (1.05)	671 (618 to 723)	49.9	356	53.1
Maryland	41 068 (40 947 to 41 190)	51 296 (1.25)	10 228 (10 106 to 10 349)	169.2	6805	66.5
Massachusetts	48 764 (48 630 to 48 899)	58 723 (1.20)	9959 (9824 to 10 093)	144.5	10 237	102.8
Michigan	81 079 (80 892 to 81 265)	98 891 (1.22)	17 812 (17 626 to 17 999)	178.4	12 372	69.5
Minnesota	38 264 (38 147 to 38 381)	44 383 (1.16)	6119 (6002 to 6236)	108.5	5897	96.4
Mississippi	26 185 (26 096 to 26 275)	33 919 (1.30)	7734 (7644 to 7823)	259.9	5142	66.5
Missouri	53 505 (53 361 to 53 649)	64 960 (1.21)	11 455 (11 311 to 11 599)	186.6	8052	70.3
Montana	8642 (8602 to 8681)	10 254 (1.19)	1612 (1573 to 1652)	150.9	1231	76.3
Nebraska	14 075 (14 018 to 14 132)	16 867 (1.20)	2792 (2735 to 2849)	144.3	2258	80.9
Nevada	21 547 (21 469 to 21 626)	26 780 (1.24)	5233 (5154 to 5311)	169.9	3576	68.3
New Hampshire	10 212 (10 167 to 10 257)	11 491 (1.13)	1279 (1234 to 1324)	94.0	768	60.1
New Jersey	60 594 (60 440 to 60 749)	82 871 (1.37)	22 277 (22 122 to 22 431)	250.8	18 180	81.6
New Mexico	15 294 (15 233 to 15 354)	19 466 (1.27)	4172 (4112 to 4233)	199.0	2792	66.9
New York	126 811 (126 571 to 127 050)	175 160 (1.38)	48 349 (48 110 to 48 589)	248.5	38 596	79.8
North Dakota	6079 (6049 to 6109)	7590 (1.25)	1511 (1481 to 1541)	198.3	1428	94.5
Ohio	100 843 (100 632 to 101 054)	123 114 (1.22)	22 271 (22 060 to 22 482)	190.5	15 178	68.2
Oklahoma	32 559 (32 455 to 32 662)	39 410 (1.21)	6851 (6748 to 6955)	173.1	5254	76.7
Oregon	30 551 (30 451 to 30 650)	34 063 (1.11)	3512 (3413 to 3612)	83.3	1558	44.4
Pennsylvania	109 953 (109 732 to 110 173)	133 247 (1.21)	23 294 (23 074 to 23 515)	182.0	18 690	80.2
Rhode Island	8719 (8679 to 8759)	10 408 (1.19)	1689 (1649 to 1729)	159.4	1873	110.9
South Carolina	41 606 (41 483 to 41 729)	50 518 (1.21)	8912 (8789 to 9035)	173.1	5545	62.2
South Dakota	6882 (6849 to 6915)	8766 (1.27)	1884 (1851 to 1917)	213.0	1666	88.4
Tennessee	62 606 (62 446 to 62 765)	75 504 (1.21)	12 898 (12 739 to 13 058)	188.9	8027	62.2
Texas	168 716 (168 432 to 168 999)	218 242 (1.29)	49 526 (49 243 to 49 810)	170.8	33 828	68.3
Utah	15 985 (15 922 to 16 048)	18 905 (1.18)	2920 (2857 to 2983)	91.1	1618	55.4
Vermont	4837 (4812 to 4862)	5217 (1.08)	380 (355 to 405)	60.9	106	27.9
Virginia	57 788 (57 637 to 57 940)	67 478 (1.17)	9690 (9538 to 9841)	113.5	6244	64.4

(continued)

Table. Excess Deaths, March 1, 2020, to January 2, 2021, US and Selected States and Regions (continued)

Jurisdiction	Expected deaths (95% CI) <sup>a</sup>	Observed deaths (ratio of observed to expected)	Excess deaths, No. (95% CI)	Excess deaths/100 000 <sup>b</sup>	COVID-19 deaths <sup>c</sup>	Excess deaths attributed to COVID-19, % <sup>c</sup>
Washington	47 196 (47 063 to 47 328)	53 159 (1.13)	5963 (5831 to 6096)	78.3	3662	61.4
West Virginia	18 970 (18 899 to 19 041)	21 332 (1.12)	2362 (2291 to 2433)	131.8	1535	65.0
Wisconsin	45 013 (44 884 to 45 143)	53 256 (1.18)	8243 (8113 to 8372)	141.6	6325	76.7
Wyoming	3890 (3869 to 3912)	4734 (1.22)	844 (822 to 865)	145.8	416	49.3

<sup>a</sup> Seasonally adjusted death counts predicted by regression model (see Methods).

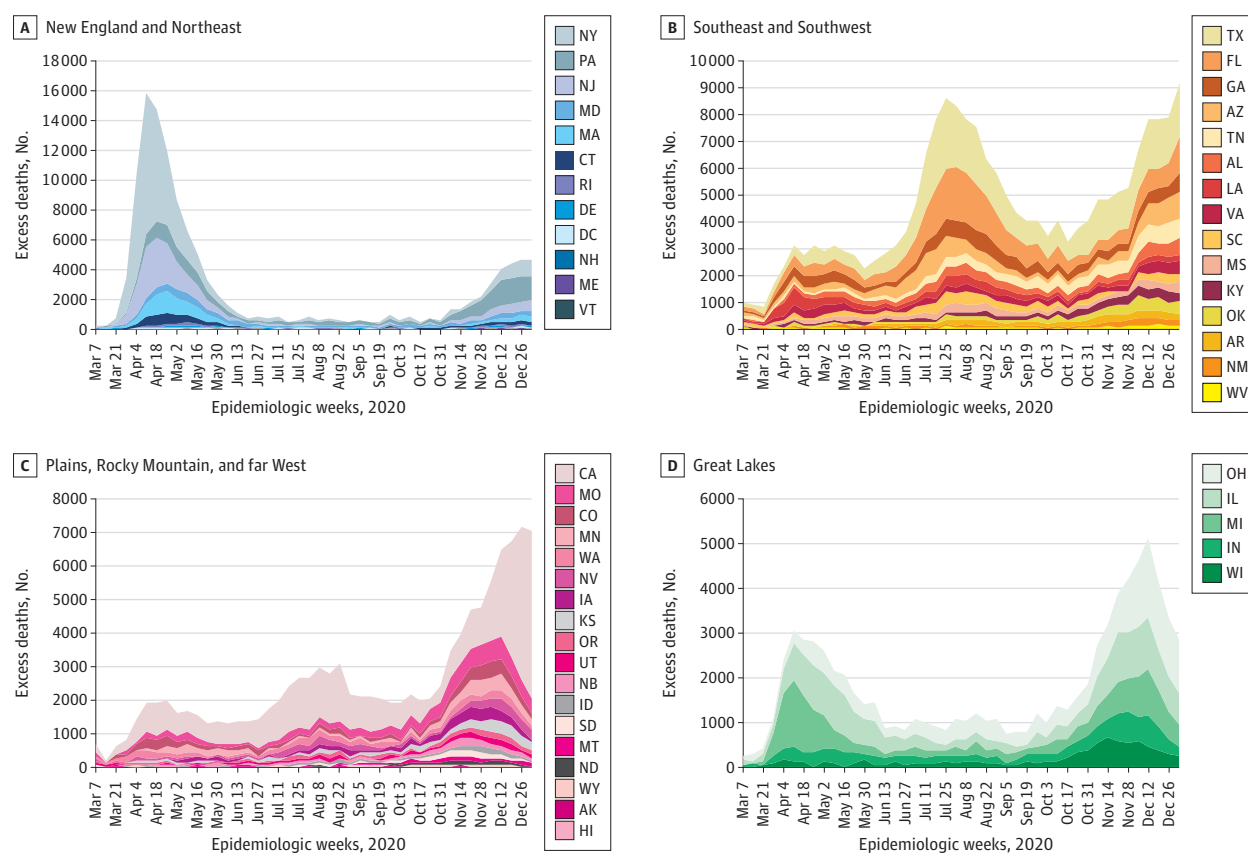
<sup>b</sup> Values shown are not annual mortality rates. The numerator counts only excess deaths that occurred between March 1, 2020, and January 2, 2021.

<sup>c</sup> COVID-19 deaths include deaths in which COVID-19 was identified as the underlying or a contributing cause of death (among multiple causes of death).

COVID-19 deaths in Hawaii, Massachusetts, and Rhode Island exceeded the estimate for excess deaths, in part because observed deaths from other causes were lower than would be predicted according to historic norms.

<sup>d</sup> The US total was calculated as the sum of results for 49 states and the District of Columbia. North Carolina was omitted because of delays in reporting.

Figure. Excess Deaths by Regions, March 1, 2020, to January 2, 2021



State data plotted from 8 regions, as defined by the [US Bureau of Economic Analysis](#). Surge patterns were independently examined for each of the 8 regions ([Supplement](#)); epidemic patterns were similar and could be merged as shown,

except a bimodal pattern in the Great Lakes region was distinctive and plotted separately. Negative excess deaths were plotted as zero. State-level data are available on request.

primarily in early winter; and in the Great Lakes, bimodally, in the spring and early winter (**Figure**). Excess deaths were increasing in all regions at the end of 2020. The 10 states with the highest per capita rate of excess deaths were Mississippi, New Jersey, New York, Arizona, Alabama, Louisiana, South Dakota, New Mexico, North Dakota, and Ohio. New York experienced the largest relative increase in all-cause mortality (38.1%). Deaths attributed to COVID-19 accounted for 72.4% of US excess deaths.

Joinpoint analyses revealed an increase in weekly mortality from non-COVID-19 causes, including heart disease from March 15 to April 11, 2020 (APC, 4.9 [95% CI, 0.7-9.3]), and from October 11, 2020, to January 2, 2021 (APC, 1.1 [95% CI, 0.8-1.4]); Alzheimer disease/dementia from March 15 to April 11, 2020 (APC, 7.1 [95% CI, 2.4-12.0]), from May 31 to August 15, 2020 (APC, 1.2 [95% CI, 0.7-1.6]), and from September 6, 2020, to January 2, 2021 (APC, 1.3 [95% CI, 1.1-1.5]); and diabetes from March 8 to April 11, 2020 (APC, 6.5

[95% CI, 2.8-10.3]), from May 31 to July 11, 2020 (APC, 2.6 [95% CI, 0.2-5.0]), and from October 18, 2020, to January 2, 2021 (APC, 2.2 [95% CI, 1.6-2.8]).

**Discussion** | The 22.9% increase in all-cause mortality reported here far exceeds annual increases observed in recent years ( $\leq 2.5\%$ ). The percentage of excess deaths among non-Hispanic Black individuals (16.9%) exceeded their share of the US population (12.5%),<sup>5</sup> reflecting racial disparities in COVID-19 mortality. Excess deaths surged in the east in April, followed by extended summer and early winter surges concentrated in southern and western states, respectively. Many of these states weakly embraced, or discouraged, pandemic control measures and lifted restrictions earlier than other states.<sup>1,6</sup>

Excess deaths not attributed to COVID-19 could reflect either immediate or delayed mortality from undocumented COVID-19 infection, or non-COVID-19 deaths secondary to the pandemic, such as from delayed care or behavioral health crises. Death rates from several non-COVID-19 diseases (eg, heart disease, Alzheimer disease) increased during surges. The model does not adjust directly for population aging, which could contribute to an overestimate of excess deaths. Other study limitations include reliance on provisional data, inaccurate death certificates, and modeling assumptions.

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## Trends in the Prevalence of Concussion Reported by US Adolescents, 2016-2020

In 2016, 19.5% of US adolescents reported at least 1 concussion during their lifetime.<sup>1,2</sup> While knowledge about concussion and management of these injuries within the adolescent population have increased over the past decade,<sup>3</sup> to our knowledge, no national study has tracked whether rates of concussion have declined or increased. This study estimated trends in the lifetime prevalence of self-reported concussion among a national sample of adolescents between 2016 and 2020.

**Methods** | This study uses national cross-sectional data from the 2016-2020 Monitoring the Future (MTF) initiative.<sup>4</sup> The MTF initiative is an annual school-based survey of 8th-, 10th-, and 12th-graders conducted between February and June each school year; surveys are administered in classrooms and completed during normal class periods. The MTF stopped data collection for the 2020 survey early on March 14, 2020, due to COVID-19 (a representative sample was still maintained). The student response rates between 2016 and 2020 ranged from 79% to 90%. The University of Michigan institutional review board approved this study. A waiver of informed consent was sent to parents providing them a means to decline their child's participation.

A measure to assess concussion was added to the MTF in 2016, asking respondents the following: "Have you ever had a head injury that was diagnosed as a concussion?" Response options included "no," "yes, once," and "yes, more than once." The measure did not change across the 5 years.

Binary regression models (using Mplus 8.1) estimated linear trends for self-reported concussion; adjusted models controlled for sex, race/ethnicity, grade level, parental education, and participation in sports. Analyses report the unadjusted prevalence ratios, adjusted prevalence ratios, and 95% CIs. Statistical significance was set at  $\alpha \leq .05$  for a 2-tailed test when assessing linear trends. Full information maximum likelihood estimation was used to account for item missingness for each of the binary regression models. All analyses take into account the complex multistage sampling design, including clustering of respondents in primary sampling units<sup>4</sup>; weights were incorporated to provide nationally representative estimates